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KIM MARSHALL
MANAGER EXAMINATION SUPPORT AND SALES

A PATHOLOGY SAMPLE TUBE DISTRIBUTOR

FIELD OF INVENTION

THIS INVENTION relates in particular to but is not limited to a pathology specimen tube distributor and system for use in medical pathology laboratories.

BACKGROUND ART

The collection and analysis of pathology specimens such as blood involves numerous steps which are prone to human error which could result in disastrous consequences for both the medical laboratory and the patient concerned. One fundamental area where such errors can occur is the transfer of the specimen from the primary specimen tubes containing the specimen first collected from a patient to the secondary sample tubes which contain aliquots of the specimen for actual analysis by an analysing instrument. Major problems occur where tubes are incorrectly labelled or the tubes are of an incorrect type for a particular test specifically requisitioned by a physician. In order to solve these and other problems, most pathology laboratories have in place numerous time consuming manual checking procedures. As a consequence of the advent of highly contagious and dangerous diseases such as AIDS and hepatitis and advances in computer technology, much of the organisation and transfer of the secondary sample tubes to racks or holders for the purpose of analysis is now substantially automated. The whole process is often monitored to an extent such that an enquiry of the computer system involved will reveal the location of the primary specimen tube and/or secondary sample tubes at any stage of the tube management and analytical process.

Invariably, pathology specimen distribution centres are often placed invidiously in what can only be described as a "meat in the sandwich" situation. This may be given by way of example where the distribution centre has to decide which test is appropriate when the full spectrum of test procedures is not known or understood by the referring physician, or, when the scientist responsible for the analytical procedures has not clearly spelt out to the specimen collecting staff what type and amount of specimen is required. This situation is often resolved by obtaining further specimens from the patient which is wasteful of time and resources such as disposables and extra specimen tubes or containers. The possibility of errors in such situations is often further compounded by the limitations of the laboratory's computer information management system which is only as accurate as the information provided to it. Unless the laboratory has an automated specimen distribution system, human error can easily be introduced into a manual specimen tube management system because the laboratory's primary focus is in the analysis of samples and the actual reporting of the results which is often to the detriment of attention to other areas prone to error. As a consequence of the absence of an accurate fail safe tube management system, it may be impossible to know if a correct specimen type has been collected until it is delivered to the scientist at the analyser. The scientist will also have to decide at this stage whether a sufficient sample volume has been collected for the particular analysis and whether or not the sample for example if it is blood is too haemolysed or clotted for a particular test to be carried out. As a result many of the errors found in laboratories have their origin at the specimen distribution centre and such errors become compounded as the laboratory process continues.

As a consequence of the absence of automated tube management systems, there are often inefficient manual sample storage facilities resulting in the misplacement of samples received so that the result obtained if inconsistent with what is expected has to be rechecked by re-running the test against a reference source to verify the particular infection. In laboratories where there are no reliable sample storage systems, there is usually a proliferation of various systems which are not under computer control resulting in unnecessary costs including those incurred in the scientists having to re perform the tests as mentioned above.

In attempting to identify these and other problems, the inventor has listed a number of deficient areas found in current manual systems and those systems necessarily involving other instruments and tests. Some of these deficiencies include the transportation of uncapped primary and secondary tubes resulting in the increased possibility of laboratory and sample tube contamination. The fact that the same specimen type can be collected in different tube types having different colour coded caps can also result in confused or erroneous readings by instruments or staff unfamiliar with a particular manufacturer's colour code. In addition, the presence of different cap types and different clot activating substances being used by different physicians for collected blood specimens can cause the laboratory to restrict itself to one collection tube manufacture in the interest of eliminating errors. Furthermore, the particular tube transport mechanism associated with a specific test often dictates the design of the laboratory and results in restricting the tube management system to one analysis type only. Other limitations include the inability to distribute samples from one collection resulting in multiple collections of the same specimen type where it is

necessary to repeat the same test or where other tests on the same type of specimen are involved.

Prior art solutions to the above problems have therefore included a number of systems presently in operation which may be broadly categorised as follows:-

1. Continuation of an existing manually controlled system. In this case the laboratories take advantage of various analysers that are capable of bar code reading and manually interfacing them with the laboratory's existing computer information management system based on bar coding. This has often resulted in the collection of more specimens from the patients in order to distribute each separate collection tube to a specific analyser resulting in a wastage of specimen and problems associated where a great number of tubes have to be handled, for example, misplacement of sample tubes, accidental spillage and the possibility of contamination.
2. Systems which utilise a conveyor belt that transports the collected specimen tubes to an appropriate work station where a tube is captured and acted upon by a number of processes inclusive of picking up the tube and putting it in a storage rack. The system then recaps the specimen tubes and transports the capped tubes to their destination. In this system there is no computerised management system so that each laboratory has to write its own manually controlled management system in respect of the whole process.
3. Systems which utilise the conveyor belt system but are limited by utilising one manufacturer's specimen tube type only. This system processes the specimen by the tipping the collection tube in an inverted position,

inserting a disposable plastic device into the specimen tube and then pumping in air to expel a sample of the specimen to a secondary tube of a certain type.

4. Systems which use a robotic arm to uncap and distribute specimen tubes in which the primary specimen is collected without any distribution or transfer of sample amounts or aliquots to secondary tubes.

5. Systems which utilise a needle to pierce the cap of the primary specimen tube and distribute sample aliquots to unlabelled and uncapped secondary tubes in a rack that holds all the tubes associated with the particular primary specimen tube.

Specific problems which have been identified by the inventor associated with the prior art systems described above include the following:-

1. Conveyor belt systems are large and bulky and often cut across doorways and require major remodelling and restructuring of the laboratory.

2. Prior art tube distribution systems are often restricted to primary specimen tubes and secondary sample tubes of a certain type or make. Where specimen and/or sample tubes not of the type associated with the particular prior art system are used, this can result in breakages of the tubes during processing resulting in the loss of the specimen and/or contamination of apparatus.

3. There is often an absence of an on board computerised tube monitoring facility to keep track of the physical status of the tubes which can result in exposure to uncapped tubes causing contamination of the sample as well as the laboratory environment.

4. Systems where the available sample volume is not measured prior to the aspiration of the sample resulting in the situation that multiple samples cannot be obtained from the single specimen for example where one tube of blood is insufficient for the battery of tests requested and therefore two or more tubes have to be further collected.
5. Systems which are restricted to certain types of specimens such that the systems are not able to cope with specimens of serum, plasma, urine and other fluids from a single patient.
6. Systems where the recapping of primary specimen tubes are made with another cap resulting in higher running costs and design constraints which may result in spillage and the possibility of contamination when a tube is broken or dropped due to the extra handling of the tube associated with the recapping process.
7. A restriction on rack types or holders required by separate analysing instrument systems.
8. The absence of systems where there is an automated labelling of the secondary sample tubes resulting in an increased chance of human error.
9. Systems where the cost effective sealing of secondary tubes by the use of plastic laminate instead of caps is not provided for.
10. Systems which cannot identify the physical characteristics of a particular specimen tube and/or the specimen in the tube prior to processing.
11. Systems which cannot process more than one type of primary specimen tube or secondary sample tube as previously described.

OBJECT OF THE INVENTION

It is therefore an object of the present invention to alleviate to some degree some of the abovementioned problems associated with prior art pathology sample tube distributors presently in operation.

The applicant has described the inventions below both independently and in a preferred combination with a view to requesting an "International Type Search" on the present provisional application. Accordingly, the applicant reserves the right to divide the invention from the present application or to claim the inventions in novel combination in response to the outcome of the search.

SUMMARY OF THE INVENTION

In a preferred aspect the invention resides in a pathology specimen tube distributor having the improvement of specimen tube receiving and identification means comprising a bar code scanner to scan bar coded labels and an image analyser to analyse the physical characteristics of the specimen tube and/or the level of specimen in the tube. The image analyser comprising a digital camera and a light source wherein in operation the specimen tube is rotated in front of the camera so that the camera records an image of the tube, the colour of the cap of the tube and the height and number of layers of specimen and this information is processed by a computer.

In another preferred aspect the invention resides in a pathology specimen tube distributor having the improvement of cap removal and replacement means. The cap removal and replacement means comprising a specimen tube holder movable with respect a rotatable cap engagement and removal means; wherein in operation a capped specimen tube is placed in the holder and the holder

moved towards the cap engagement and removal means; the cap engagement and removal means gripping and holding the cap and rotating the cap as the holder moves away from the cap engagement and removing means thereby uncapping the specimen tube; the replacement of the cap enabled by moving the uncapped specimen tube towards the cap held by the cap engagement and removal means; the cap engagement and removal means rotating the cap as the tube is pushed onto the cap.

In another preferred aspect the invention resides in a pathology specimen tube distributor having the improvement of sample aspiration and dispensing means for aspirating and dispensing volumetrically accurate samples of specimens. The sample aspiration and dispensing means comprises a pipette tip holder; a pipette probe; an articulated arm to remove a pipette tip from the holder and place the pipette tip on the probe, and a pipette tip removing means to remove the pipette from the probe for deposition in a disposal receptacle.

In another preferred aspect the invention resides in a pathology specimen tube distributor having the improvement of blockage detection means for detecting blockage of flow in the sample aspiration means for aspirating volumetric accurate samples of specimens. The blockage detection means comprising a pressure sensitive module wherein an increase in vacuum or negative pressure provides a warning electronically or mechanically and causes the operation of the sample aspiration means to be arrested until the blockage has been resolved.

In another preferred aspect the invention resides in a pathology specimen tube distributor having the improvement of sample tube sealing means whereby

sample tubes may be sealed by the application of heat sensitive plastic laminate film. The sample tube sealing means comprising a source of laminate tape; means for punching the tape to form caps for the sample tubes; means for placing said caps over the top of the sample tubes and means for heating the caps to cause the laminate to seal the sample tube. The laminate tape preferably is dispensed from spools or reels.

In another preferred aspect the invention resides in a pathology specimen tube distributor having the improvement of automatic labelling means for the application of adhesive labels to secondary sample tubes. The automatic labelling means comprising spools of adhesive labels, a printer to apply a bar code to the adhesive labels; a bar code reader to verify that the printed matter of the labels corresponds to a bar code of a primary specimen tube associated with the secondary sample tubes; and means to detect an error in the bar code or the absence of a label.

In another preferred aspect the invention resides in a pathology specimen tube distributor having the improvement of hopper means for containing and delivering one or more secondary sample tubes; the hopper means having sample tube alignment means for aligning secondary sample tubes having a closed end and an open end from any horizontal position to a correct vertical position to receive samples, wherein the closed ends of the sample tubes are always at the bottom; the sample tube alignment means comprising a rotary magazine having circumferentially located compartments to hold horizontally positioned sample tubes in co-operation with a sideways plunger member and a guide positioned beneath the magazine to change the position of the sample tubes released from

the magazine from the horizontal to the vertical position; wherein in operation the co-operational plunger member will push a closed end of a sample tube so that the displaced sample tube released from the magazine falls into the guide in the correct vertical position; said co-operating plunger member when not in contact with a closed end, will not push a sample tube which when released, will fall into the guide in the correct vertical position.

In another preferred aspect the invention resides in a pathology specimen tube distributor comprising:-

primary specimen tube receiving and identification means; the receiving and identification means comprising a bar code scanner to scan bar coded labels and an image analyser to analyse the physical characteristics of the specimen tube and/or the specimen in the tube;

primary specimen tube cap removal and replacement means;

hopper means having sample tube alignment means for delivering secondary sample tubes in the correct vertical position to receive samples;

sample aspiration and dispensing means for aspirating and dispensing volumetrically accurate samples of specimens from the primary specimen tubes;

blockage detection means for the detecting blockage of flow in the sample aspiration means;

secondary sample tube sealing means;

secondary sample tube labelling means;

secondary sample tube storage means;

tube conveyance means;

wherein in operation a primary specimen tube containing a specimen can be presented to the receiving and identification means and the specimen tube accepted or rejected according to given criteria; the receiving and identification means being able to reject a specimen tube not able to satisfy the given criteria thereby indicating the presence of an error condition, or alternatively,

whereupon satisfying the given criteria the cap of the primary specimen tube is removed and aliquots of the specimen aspirated by the sample aspiration and dispensing means and dispensed to the secondary sample tubes which are then sealed and labelled and placed in the storage means; and whereby

the conveyance of the primary specimen tubes and secondary sample tubes between operational steps is via the tube conveyance means and the whole process is coordinated and controlled by a computerised laboratory information management system.

Suitably the primary specimen tube receiving and identification means is a receptacle for placing a primary specimen tube having a bar code scanner for scanning bar coded labels and an image analyser for analysing the colour of the cap of the specimen tube, the diameter, height and shape characteristics of the tube as well as the type and height of each layer of specimen in the tube.

Preferably the given criteria by which the primary specimen tube is accepted or rejected by the receiving and identification means includes the following criteria.

1. Is the primary specimen tube bar code present?

2. Is the presented primary specimen tube appropriate for the tests requested?
3. What type of specimen is being presented?
4. ~~Does the tube need to be sampled?~~
5. What is the available sample volume?
6. What is the height restriction for a pipette to aspirate the sample?
7. What speed should the pipette travel to maintain its tip just below the surface of the sample during the aspiration process?
8. What secondary sample tubes have to be generated?
9. What information has to be present on each label of the secondary sample tubes?
10. What destination rack is associated with the primary specimen tube and each secondary sample tube?
11. What is the order of filling the rack?
12. What spaces have to be left on the rack so that standards and controls can be later added?
13. Is the rack able to be removed?

Error conditions associated with accepting or rejecting a primary specimen tube include:-

1. The bar code is not recognised by the laboratory computerised management system.
2. The bar code is unreadable.
3. The incorrect specimen has been presented.
4. There is insufficient specimen volume in the collection for the required test which may be overridden in the case of multiple specimen collections.

5. There is a restriction to flow in the sample aspiration and dispensing means for example if the sample is blood and the blood has clotted, or the sample is too viscous or there is a jam in the hardware of the system.

Preferably the rack design incorporates its own unique bar code identifiers so that co-ordinated storage systems can be utilised as well as being completely traceable at any stage of the process.

Preferably the information on the bar code is unique to each patient episode and the collected specimens. This bar code can be used to identify and locate all the secondary sample tubes associated with the relevant primary specimen tube.

Preferably the acceptance or rejection of and error condition associated with a primary sample tube is displayed on electronic display means and/or printed means.

Suitably the specimen tube cap removal and replacement means is a robotic arm having a specially adapted member to remove and replace the cap of a specimen tube.

Preferably the one or more secondary sample tubes are plastic tubes and may have different volumes and shapes.

Preferably the sample aspiration and dispensing means has means adapted to remove and dispose of used pipette tips.

Preferably the sample tube storage means are racks for holding multiple sample tubes.

Preferably the computerised laboratory information management system is an integral part of the apparatus however may be an already existing system to which the pathology specimen tube distributor is interfaced.

Preferably the tube conveyance means is a continuous conveyer belt on which tubes may be placed in holding stands or racks. Alternatively, a robotic tray may be used for the same purpose.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 shows a schematic plan view of the invention;

Figure 2 shows the apparatus for decapping and recapping the primary specimen tubes according to the invention;

Figure 3A and Figure 3B show side elevations of the apparatus of Figure 2;

Figure 4 shows detail of the aliquot bridge of Figure 1 according to the invention;

Figure 5 shows details of the pipette arm of Figure 4;

Figure 6A and Figure 6B shows the operation of the pipette arm of Figure 5;

Figure 6C shows the sample aspiration and dispensing means according to the invention;

Figure 7A shows the secondary sample tube capping apparatus according to the invention;

Figure 7B shows a schematic plan view of the apparatus of Figure 7A;

Figure 8A shows a perspective view of the image analyser according to the invention;

Figure 8B shows a side elevation of the image analyser of Figure 8A;

Figure 9A shows the hopper means according to the invention;

Figure 9B shows an elevation of the hopper means of Figure 9A;

Figure 9C and 9D show the operation of the sideways plunger of the hopper means of Figure 9A, and

Figure 10 is a flow chart showing the basic operations of the computerised laboratory information management system according to the invention.

DETAILED DESCRIPTION OF DRAWINGS

It can be seen in the overview of Figure 1 that the pathology specimen tube distributor 1 comprises a looped tube conveyer belt 2 on which are placed primary specimen tubes 3 in holders (not shown). The primary specimen tubes 3 pass through the specimen tube receiving and identification means also known as the presented tube handler 4 rotates the primary specimen tubes for bar code reading by the bar code reader 5 and for image analysis by the image analyser 6.

Accurate quantities of samples are then automatically aspirated at the aliquot ridge 7 which incorporates the sample aspiration and dispensing means. Associated with the aliquot bridge is a pipette hopper 8 from which a disposable pipette tips are automatically loaded onto a probe (not shown) and soiled pipette tips are disposed into a bin 9. The primary specimen tubes are then recapped with their original caps and transported to a holder 11 from which they are picked up by a robotic arm (not shown) and placed in racks (not shown) in the work station 15 associated with the robotic arm.. The secondary sample tubes which are loaded from the secondary sample tube hoppers 13 pass through an automatic label printer and labeller 14. The labeller 14 applies labels to the

secondary sample tubes with information corresponding to information associated with the primary specimen tubes. The secondary sample tubes are then filled with the samples aspirated from the primary specimen tubes before being capped with laminate by the capper 10. The labelled and capped secondary sample tubes are then transferred by a robotic arm (not shown) to racks which are also placed in the work station 15.

Figure 2 shows the apparatus 16 which is responsible for decapping and recapping the primary specimen tubes presented to it. The primary specimen tube 17 is held in the grippers 18, 19 of the tube handler 20. The decapping and recapping head 21 has pneumatically operated jaws 22 coupled to a rotary actuator 23 which allows the jaws 22 to be rotated 360^0.

Figure 3A and Figure 3B are side elevations showing the decapping and recapping head of Figure 2 engaging the cap 24 of the primary specimen tube 17. The primary specimen tube is pushed in the direction of the arrow 25 by the tube handler 20 onto the decapping and recapping head 21 wherein the jaws 22 engage the upper portion of the cap. The rotary actuator 23 causes the jaws to rotate 360^0 shown by arrows 26, 27 while at the same time the primary specimen tube is pulled downwards 28 away from the cap 24 by the tube handler 20. This results in the removal of the cap from the primary specimen tube.

The recapping of the primary specimen tube 17 is the reverse of the decapping process wherein the specimen tube is pushed back onto the rotating cap 24 which prevents pressuring the tube. The jaws 22 and rotary action of the head 26, 27 are designed so that screw caps are also able to be removed and replaced.

The computerised laboratory management system (not shown) monitors that the cap has been successfully removed and may take its cue for this function by noting whether or not aspiration of the sample has been successful indicating that the cap has been removed. Other error messages which may be monitored include that the cap is too tight for the decapping and recapping head to remove.

Figure 4 shows detail of the aliquot bridge 7 of Figure 1 wherein there is shown detail of the pipette tip holder 30 holding rows of pipette tips 31, 32. The holder 30 slides in a frame 33 which allows the pipette tip holder 30 to move both horizontally and vertically. The pipette tips are pushed out of the holes 34 by the pneumatic plunger 35 which pushes them in the direction of the pipette arm 36. As a pipette tip is pushed out of its hole in each row the stopper bar 37 which passes through the frame 33 engages the next pipette tip which is moved into the correct position for the plunger 35 bar to push it out. On the exhaustion of all the pipette tips in a row the pipette tip holder 30 moves downwards as shown by arrow 38 to the next row of pipette tips. The operations of the pipette tip holder and movement of the frame in relation to the plunger are governed pneumatically. The movement of the frame is via the pneumatic actuator 39 operating on the clevis pin assembly 40.

Figure 5 shows detail of the pipette arm 36 of Figure 4. A pipette tip 41 located in the jaws 42, 43 of the pipette arm is placed over a probe 44 of the sample aspiration and dispensing means 45. Also shown in Figure 5 is a primary specimen tube 46 held in the tube handler 20. There is also shown a bar code reader 47 to read the bar code 48 on a specimen tube 49.

Figure 6A shows a side elevation of the action of the pipette arm 36 of Figure 5. The pipette arm engages a pipette tip 50 which has been pushed in the direction of arrow 51 by the plunger 35 from holes in the pipette tip holder 30 holding more pipette tips 52.

Figure 6B shows the pipette arm 36 moving in the direction of arrow 54 which places the pipette tip 50 onto the probe 44 of the sample aspiration and dispensing means 45. The pipette tip 50 is then lowered into the primary specimen tube 55 in the direction of arrow 56 to aspirate a sample of the specimen. At the same time the plunger 35 is withdrawn and the pipette tip holder 30 drops to the next row of pipette tips.

Figure 6C shows the sample aspiration and dispensing means 45 dispensing a sample aspirated from the primary specimen tube 55 to a secondary sample tube 57.

Figure 7A shows the secondary sample tube capping apparatus 60 which comprises a reel 61 holding laminate tape 62 and a take up reel 63 for the tape which has been used. The tape passes through a punch and die assembly 64 which punches caps (not shown). The caps are placed over the open ends of the secondary sample tubes 65 and the laminate is heated by the heater assembly 66 which results in the laminate 67 being applied over the top of the secondary sample tubes 68. The secondary sample tubes 68 are held in holders 69 attached to a conveyer belt 70.

Figure 7B shows a schematic plan view of the apparatus of Figure 7A. Reel 61 holding laminate tape 62 is passed over a spring loaded tensioner 71 which allows the tape to be dispensed without accelerating the reel 61 as it

passes onto rollers 72, 73. The tape passes pneumatic cylinder punches 74, 75 which punch out the caps 76 for the secondary sample tubes (not shown). The punched out caps 76 are held by a vacuum line 77 over the tops of the secondary sample tubes (not shown) wherein they are affixed using a heater assembly 78. The caps are positioned over the tops of the secondary sample tubes by a pneumatic actuator 79. Low supplies of the tape are detected by the indicator 80 in contact with the spool of tape 81. The take up reel 63 is rotated by a motor 82 and is associated with an indexing motor 83 to move the tape the correct distance pass the pneumatic cylinder punches 74, 75.

Figure 8A shows a perspective view of the image analyser 85 comprising a digital camera 86 and a bar code reader 87. Light from a fluorescent bulb 88 is shone on the primary specimen tube 89 and the digital camera 86 records the colour of the cap 90 reflected by the mirror 91 and the bar code reader 87 reads the bar code label 87a on the tube. The digital camera also records the dimensions of the tube and the height and the number of layers of specimen in the tube. In order that the specimen is correctly recorded by the digital camera, the specimen tube is held in rotating grippers 92 which rotate the specimen tube so that the camera records the portion or window of the tube not obscured by the label.

Figure 8B is a side elevation of the image analyser of Figure 8A. The image of the tube 89 reflected by the mirror 91 is captured by the lens 86a of the digital camera 86 which also records the colour of the cap 90. The bar code label 87a on the tube is read by the bar code reader 87. Illumination for imagining the tube 89 is provided by fluorescent lamps 88.

Figure 9A shows the hopper means 100 wherein horizontally aligned secondary sample tubes 101 packaged in a triangular shaped container 102 may be loaded into the upper portion of the hopper 103. The Y shaped guide 104 causes the sample tubes 105 to fall in the correct vertical position into holders 106 on a conveyer belt 107. Although not shown in detail the secondary sample tubes are delivered to a rotary magazine 108 prior to release into the guide.

Figure 9B shows an elevation of the hopper means of Figure 9A wherein the secondary sample tubes 101 from the container 102 are loaded into circumferentially located compartments 109 of the rotary magazine. The magazine is rotated by a motor 110 with a drive belt assembly 111 and secondary sample tubes 105 are allowed to fall into the guide 104 and into the holders 106 of the conveyer belt 107.

Figure 9C shows the sideways plunger 112 in co-operation with the rotary magazine 108. When the plunger 112 is not in contact with a closed end of a secondary sample tube 113 it does not displace the tube and the tube falls into the guide 104 in the correct vertical position.

Figure 9D shows the sideways plunger 112 when in contact with a closed end of a secondary sample tube 114 causes the tube to be displaced in the direction of the arrow 115 resulting in the displaced tube 114 falling into the guide 104 in the correct vertical position.

Figure 10 shows a flow chart of the computerised laboratory information management system, referred to as LIMS in the flow chart, according to the invention. A primary specimen tube containing a specimen is introduced to the system by placing it in a tube holding device (120) also referred to as the

presented tube handler in the description of Figure 1. The bar code on the primary specimen tube is read by a bar code reader (121). The specimen tube type and level of specimen in the tube is determined by the image analyser as hereinabove described (122). Patient information stored on the computerised laboratory information management system is retrieved (123) to determine what destinations or rack stations associated with the specimen require tubes (124). If no secondary sample tubes are required the primary specimen tube is delivered to a particular destination or rack in the work station area of the robotic arm as previously described. If secondary sample tubes are required, secondary sample tubes are introduced into the system (126) wherein they are labelled with information retrieved from the computerised laboratory information management system (127). The secondary sample tubes are then filled with samples aspirated from the primary specimen tube (128) and the secondary sample tubes are then automatically capped (129). The capped secondary sample tubes are then transferred to racks which are also placed in the work station of the robotic arm as previously described (130). Information concerning the placement of tubes in specific destination racks is also sent to the computerised laboratory information management system (131).

Whilst the above has been given by way of illustrative example of the present invention many variations and modifications thereto will be apparent to those skilled in the art without departing from the broad ambit and scope of the invention as herein set forth.

DATED this 27th day of November, 1997
A.i. SCIENTIFIC PTY LTD
By their Patent Attorneys
INTELLPRO

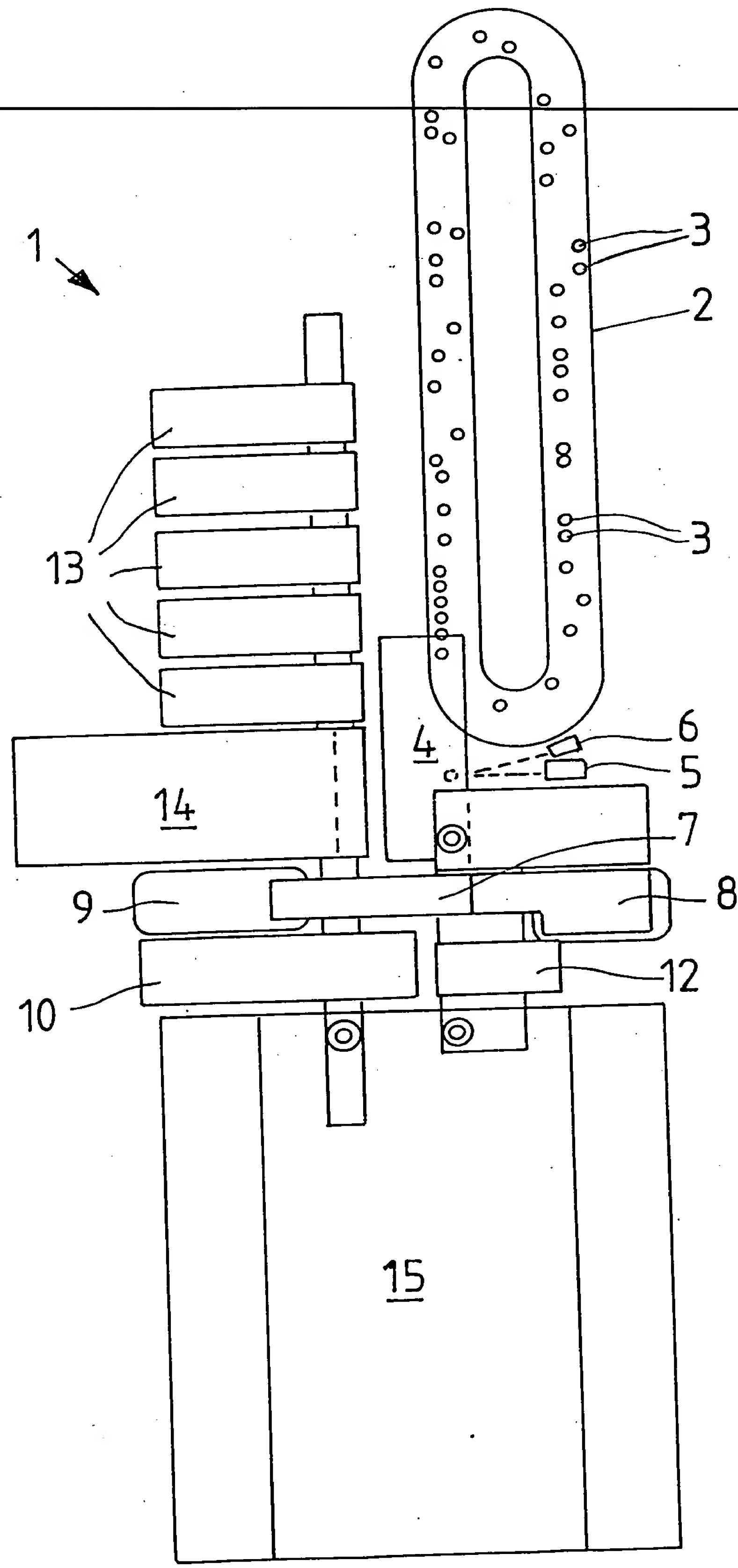

FIG. 1

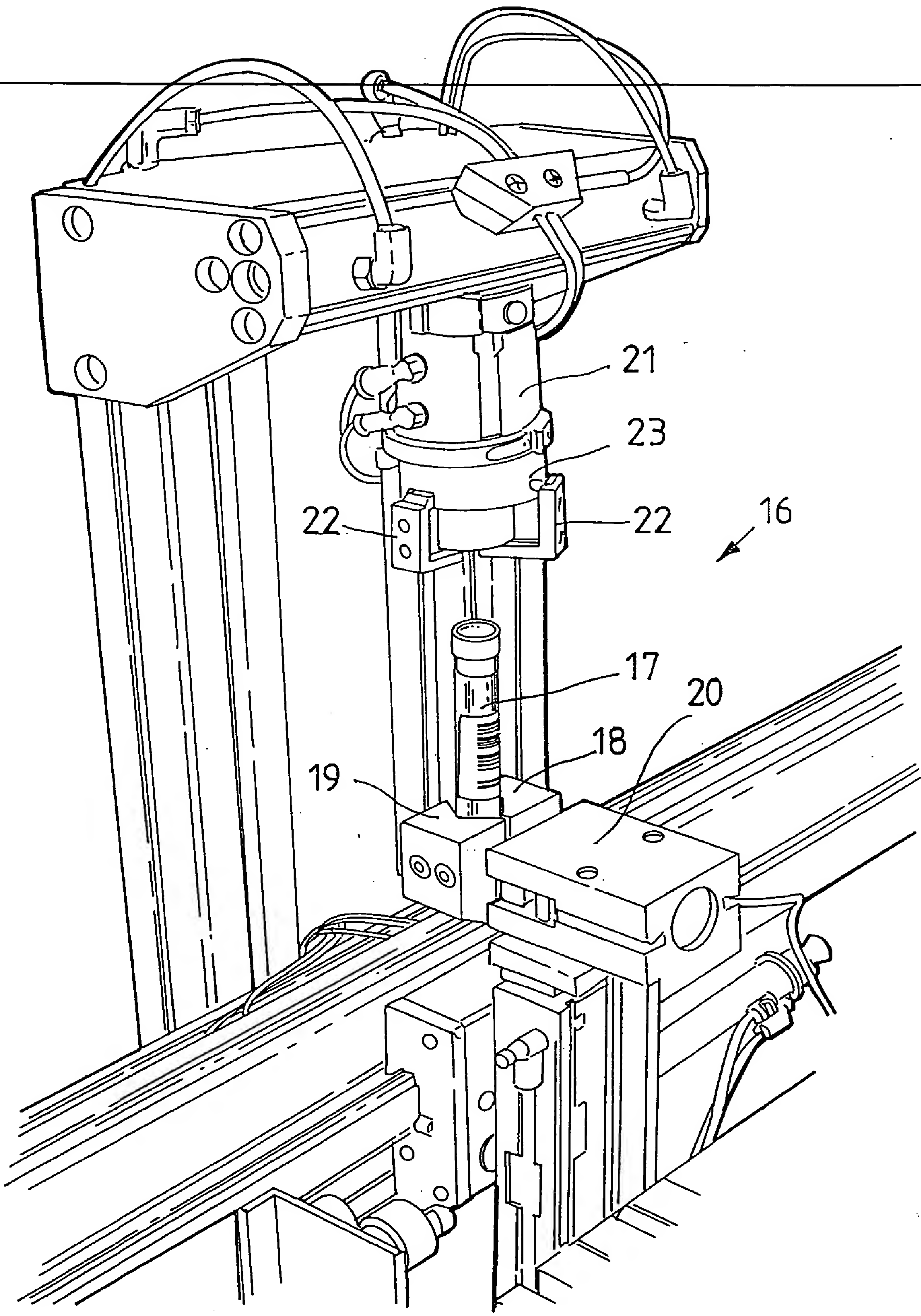

FIG. 2

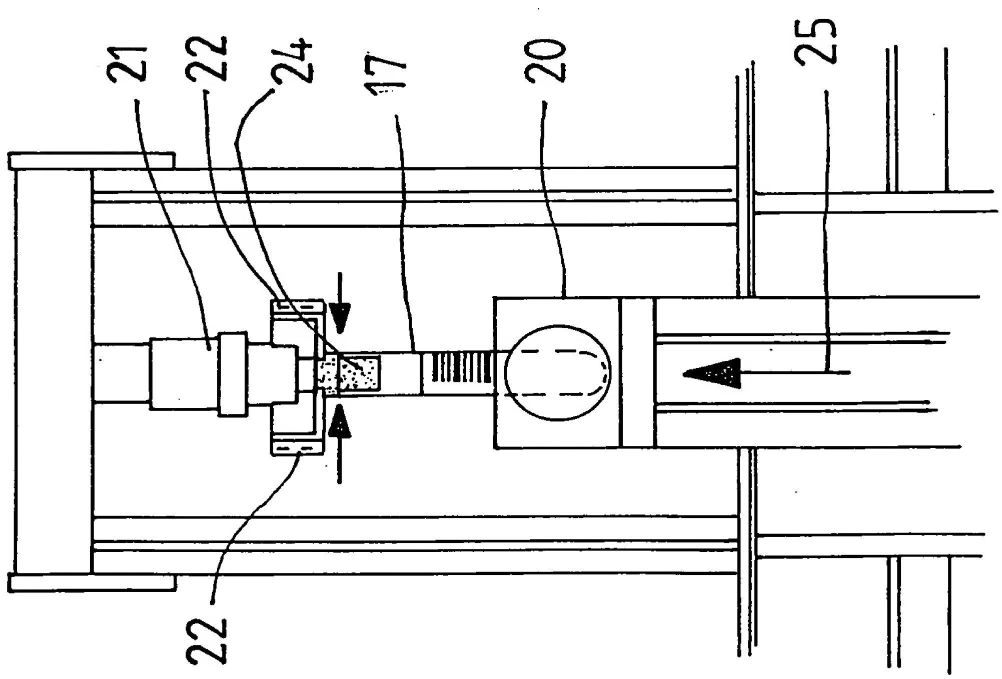

FIG. 3A

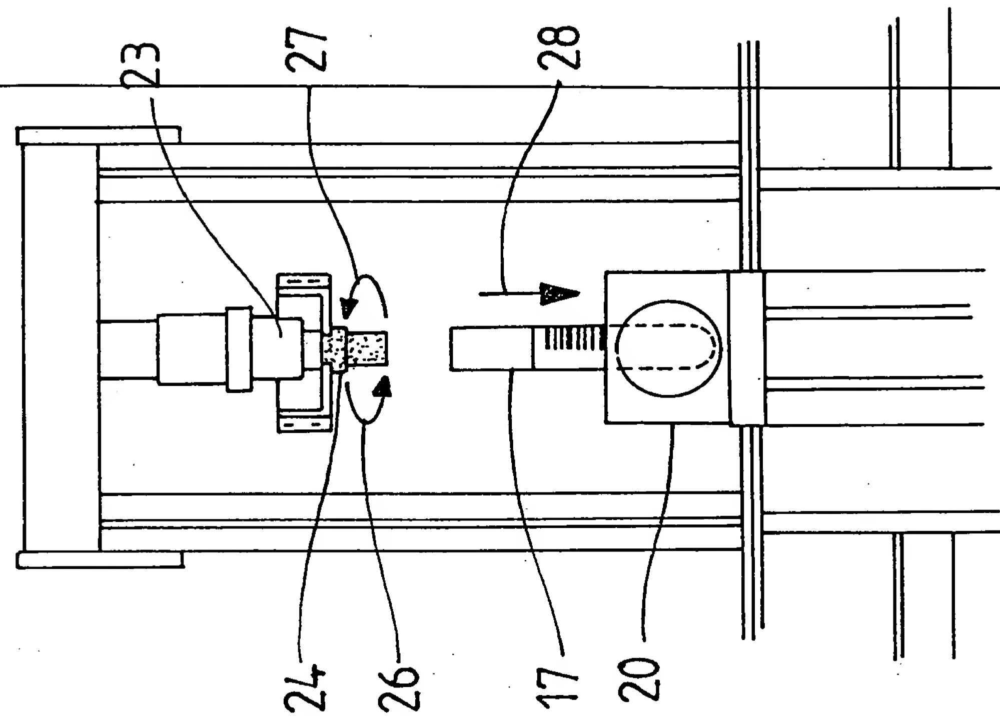

FIG. 3B

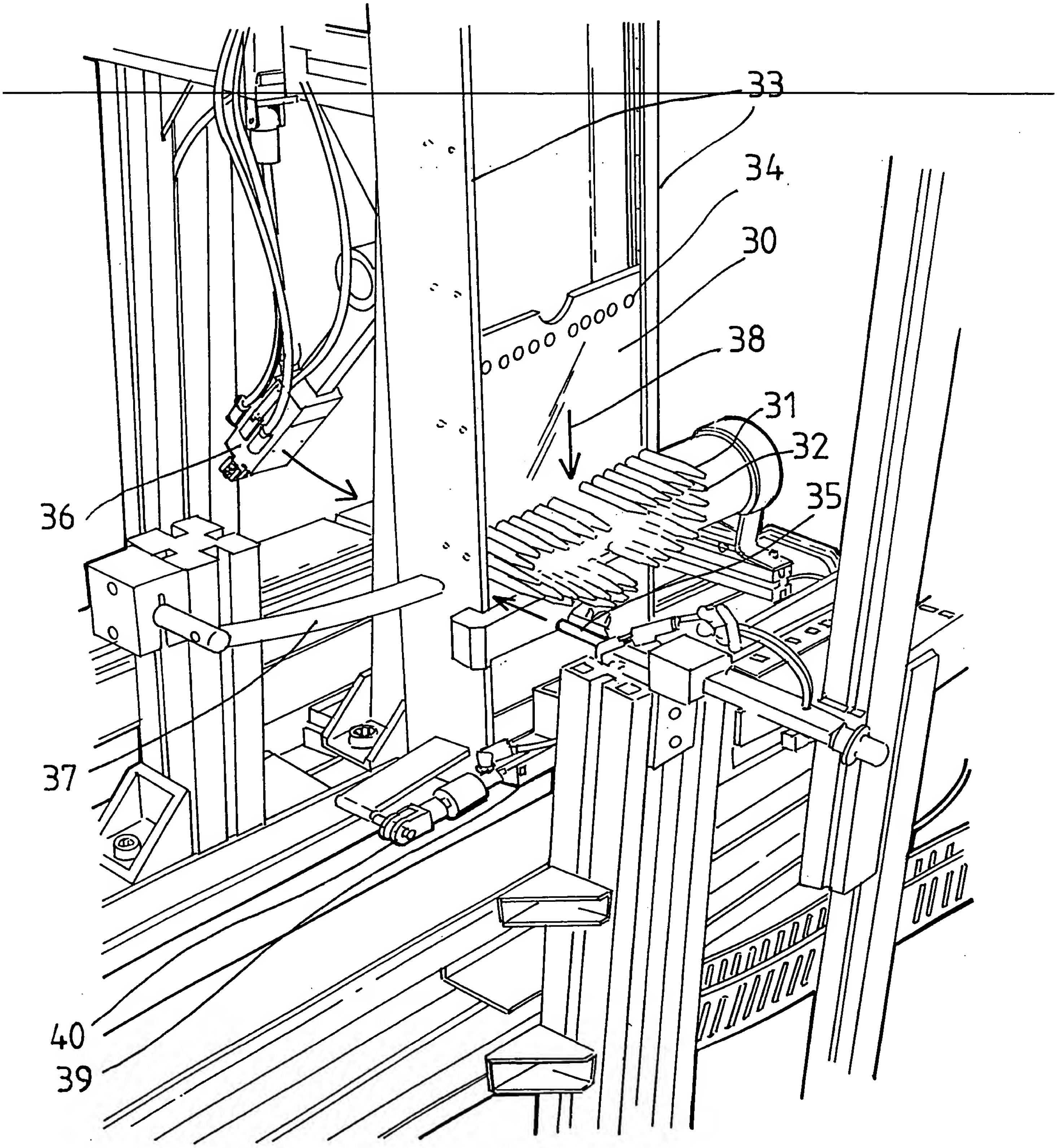

FIG. 4

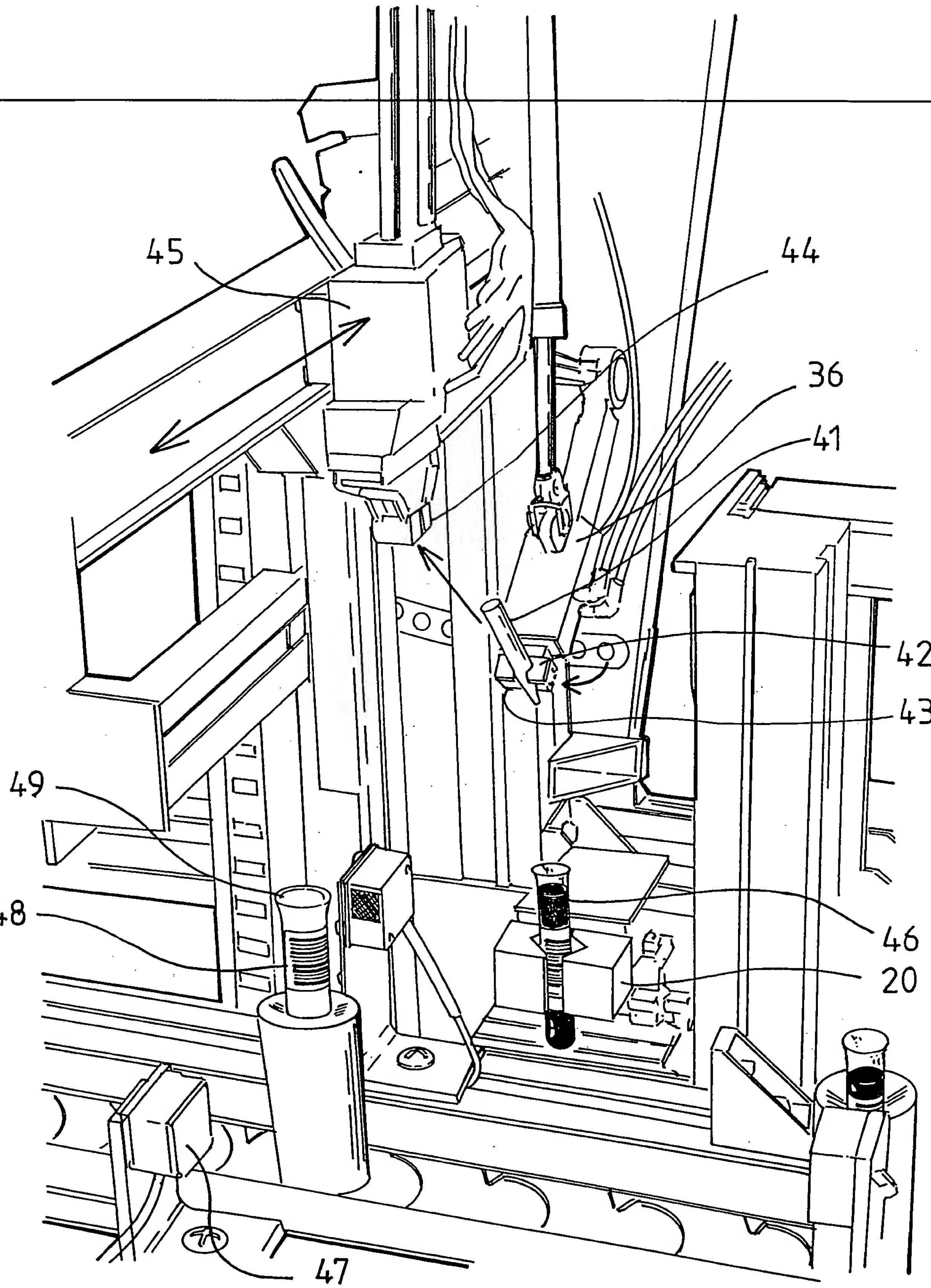

FIG. 5

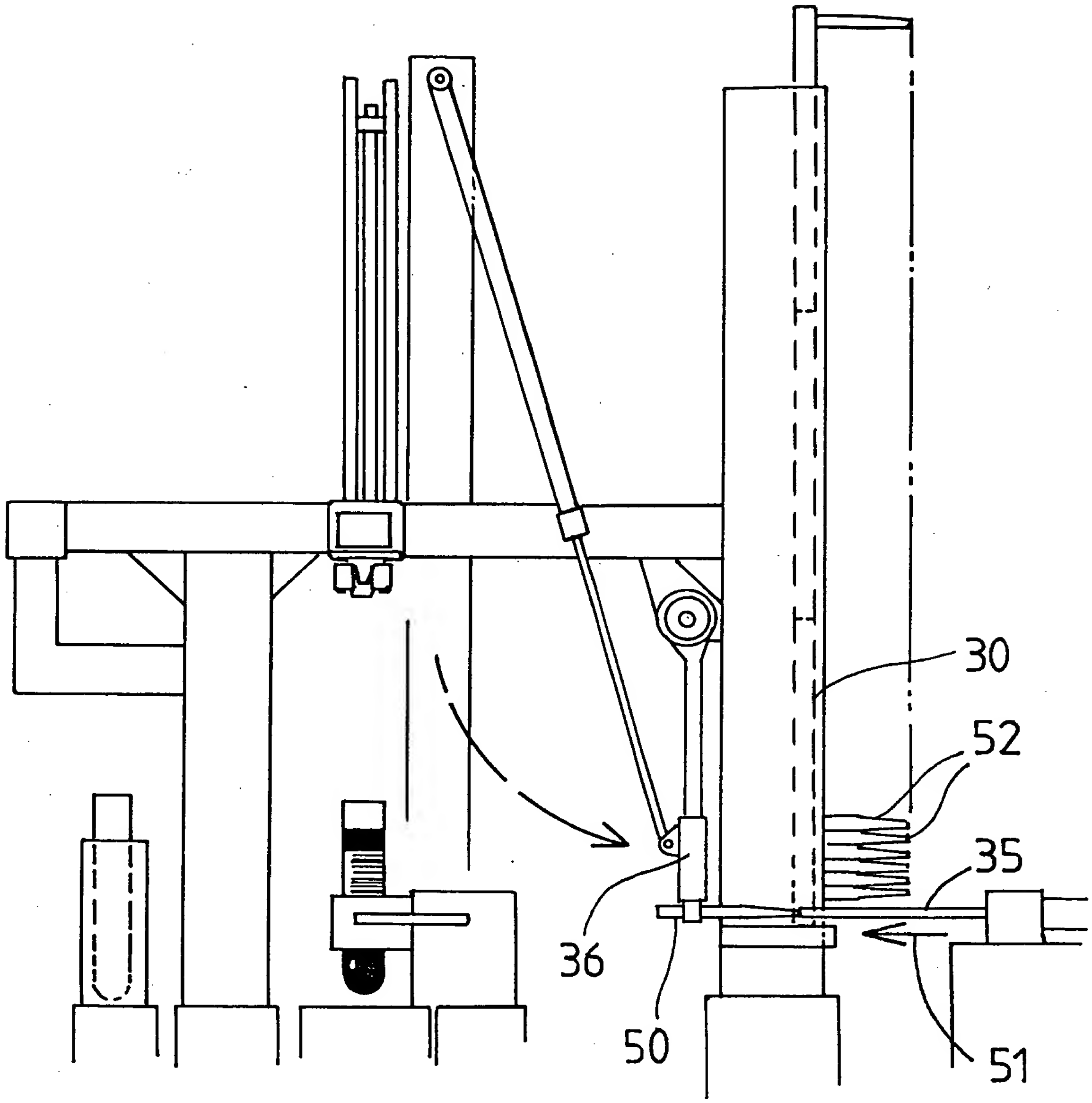

FIG. 6A

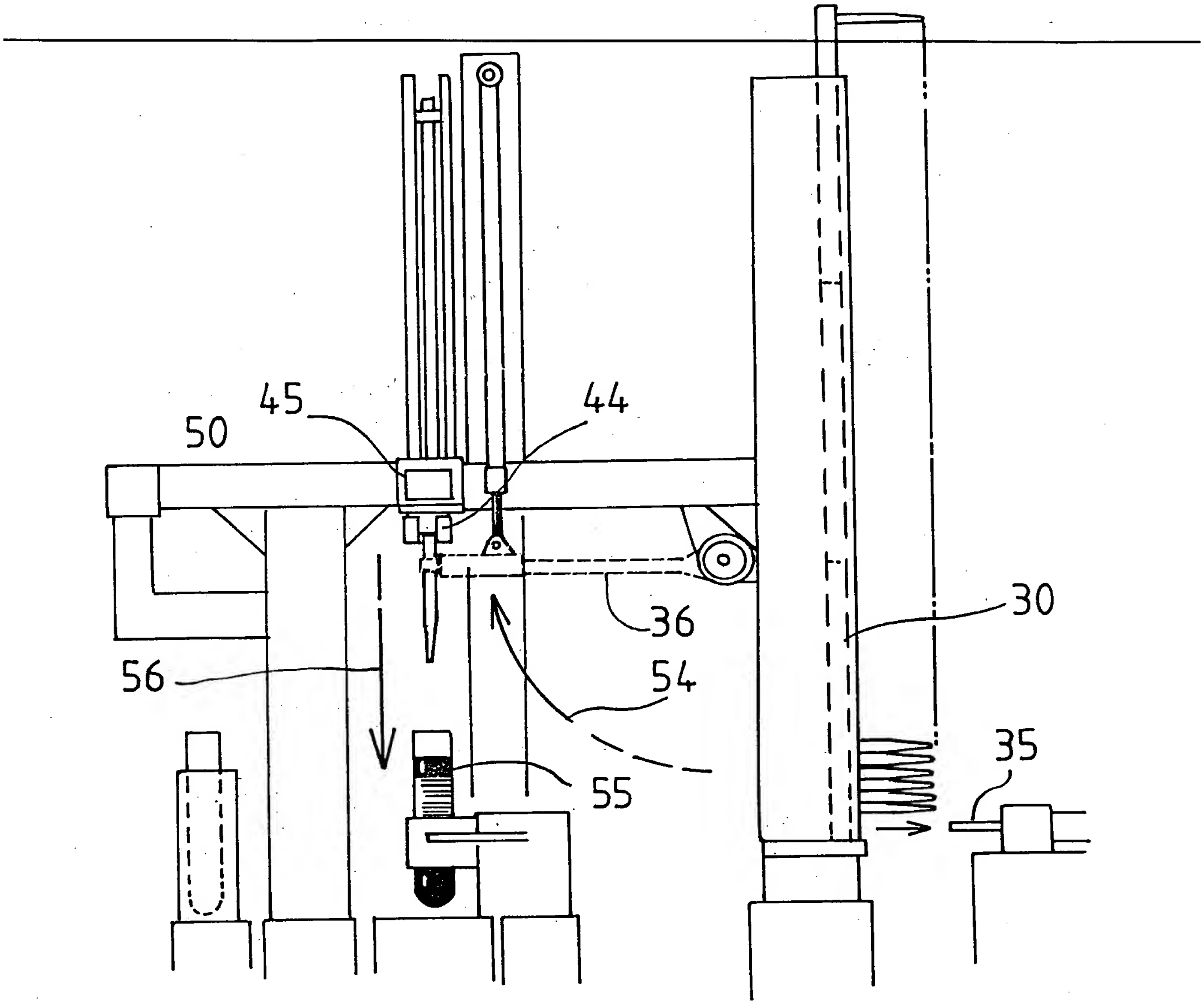

FIG. 6B

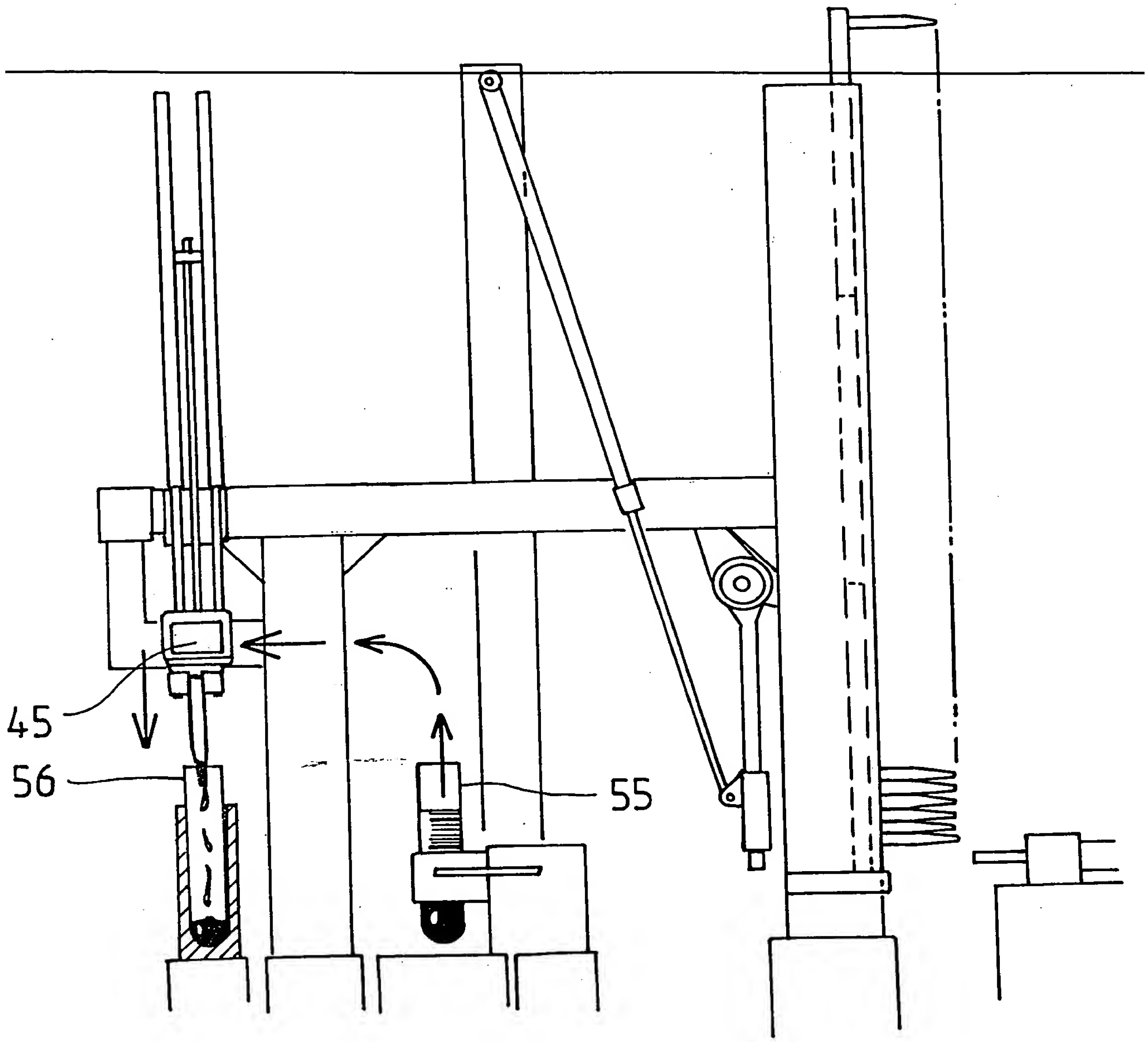

FIG. 6C

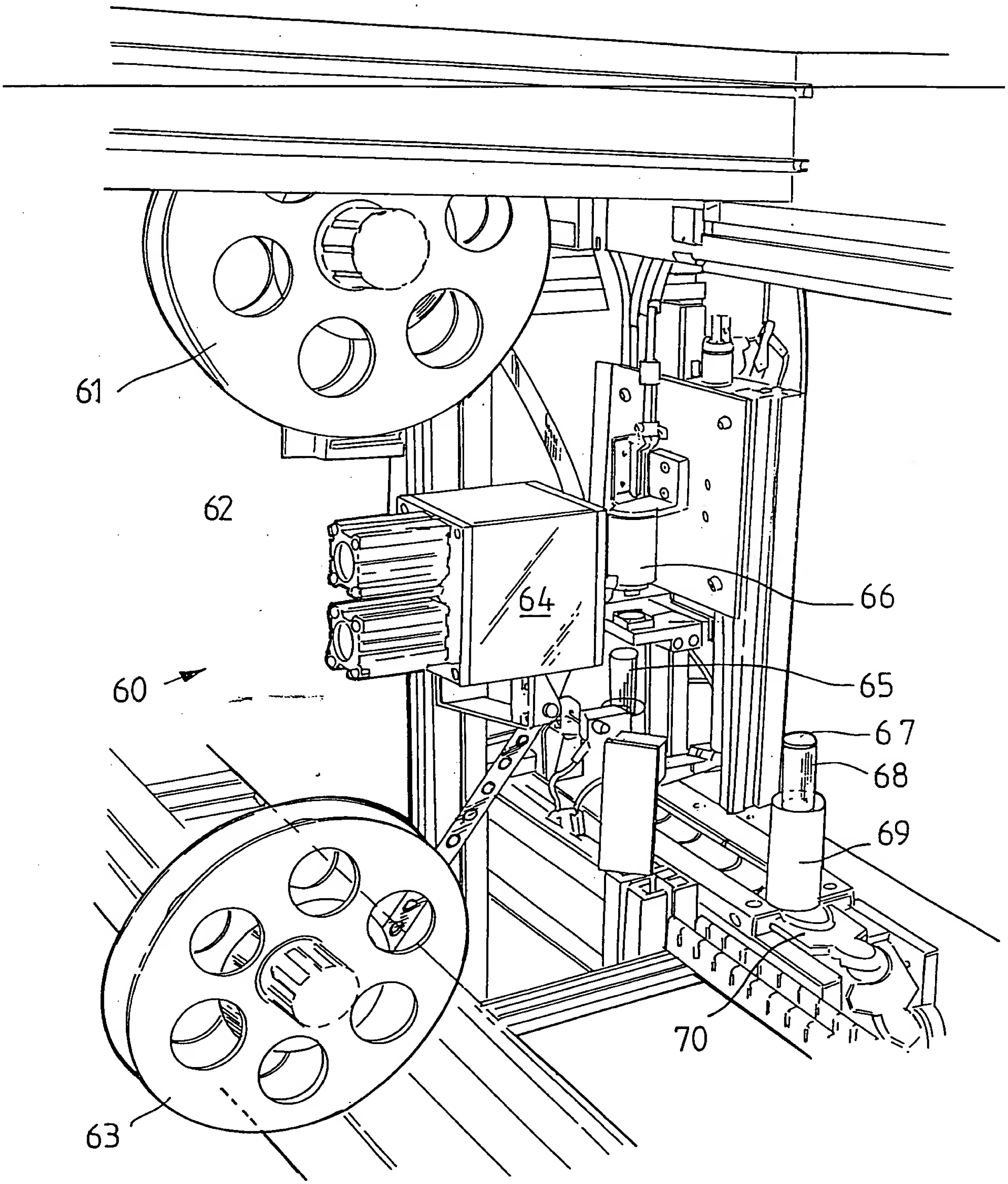

FIG. 7A

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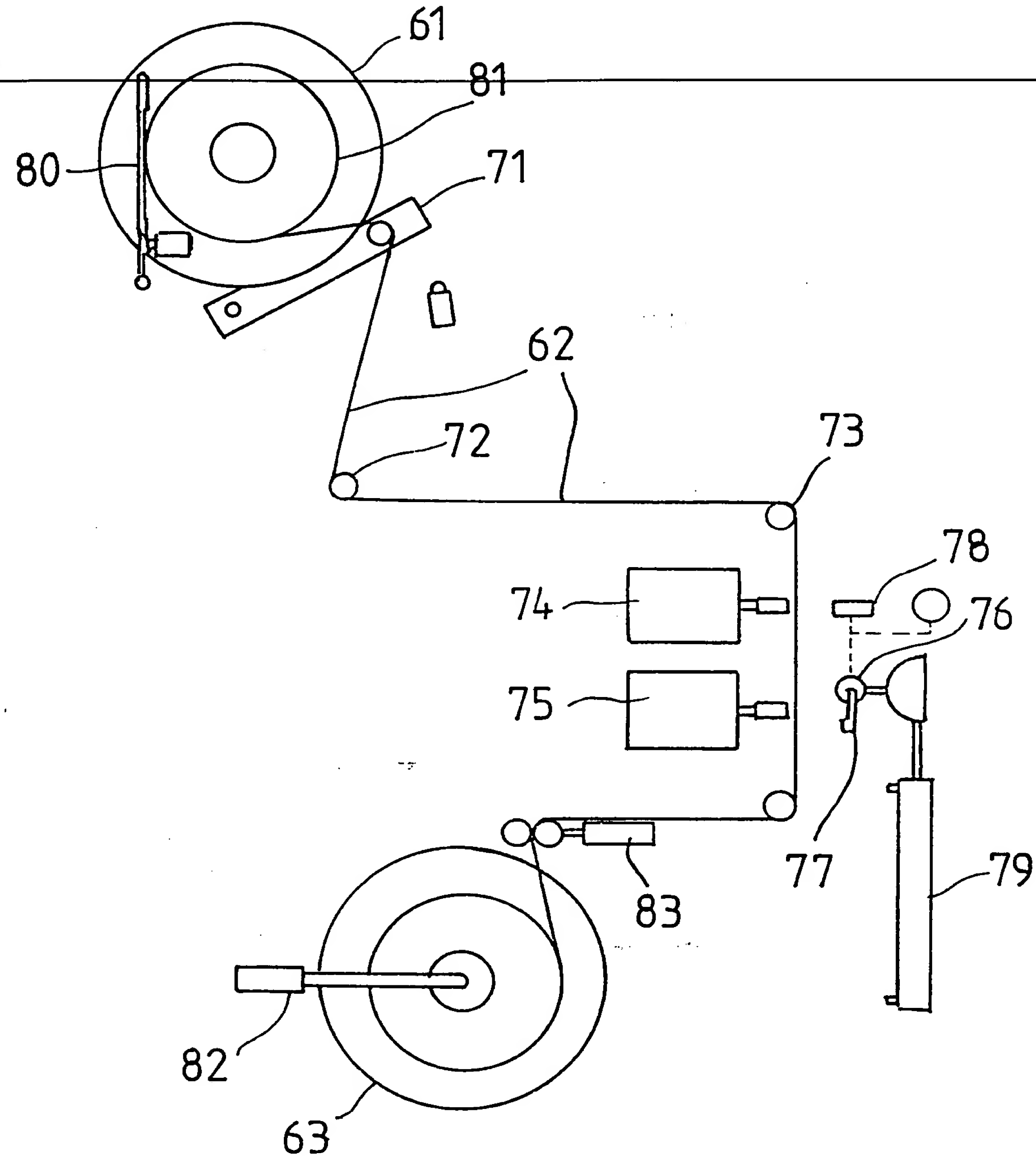

FIG. 7B

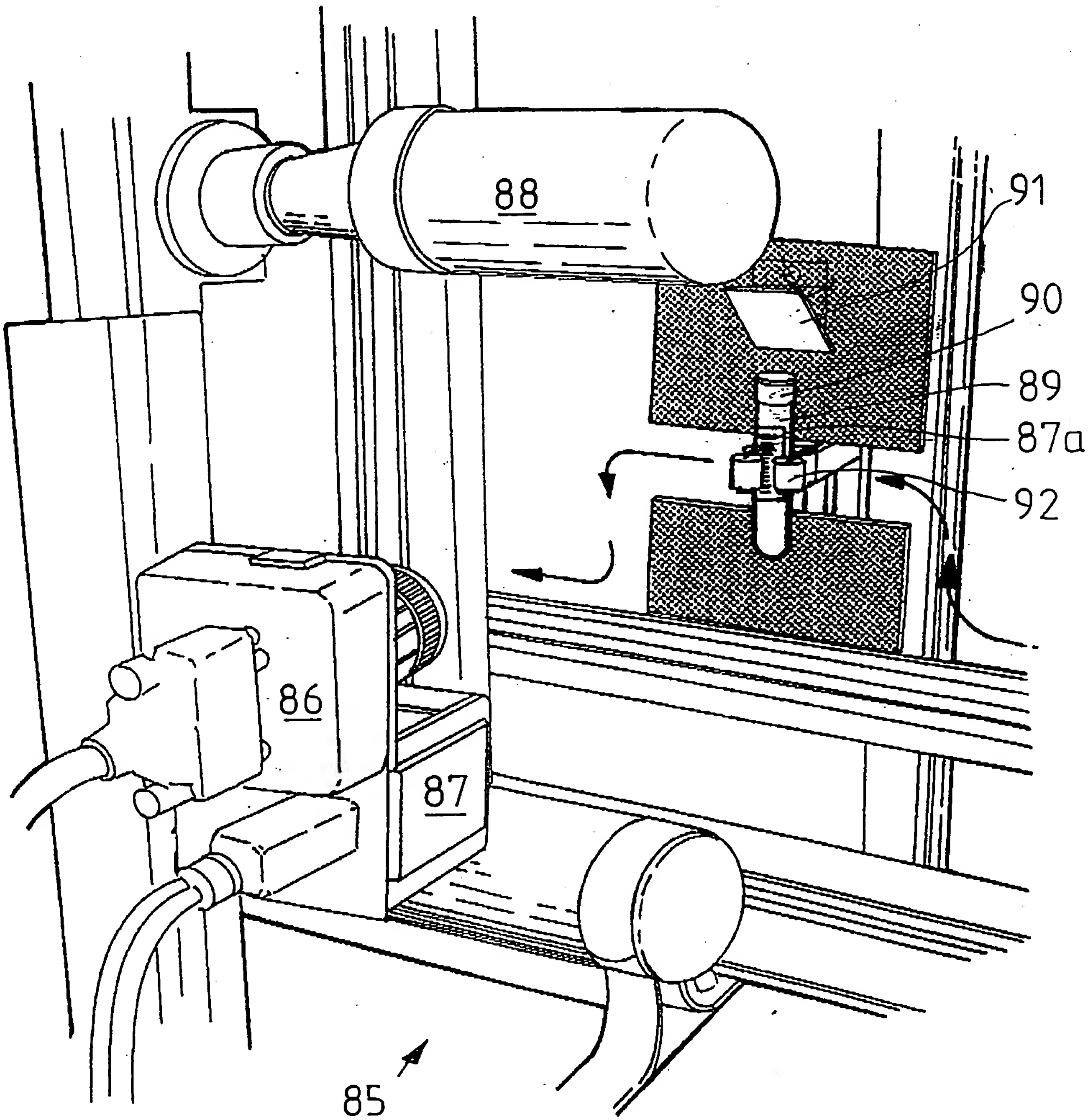

FIG. 8A

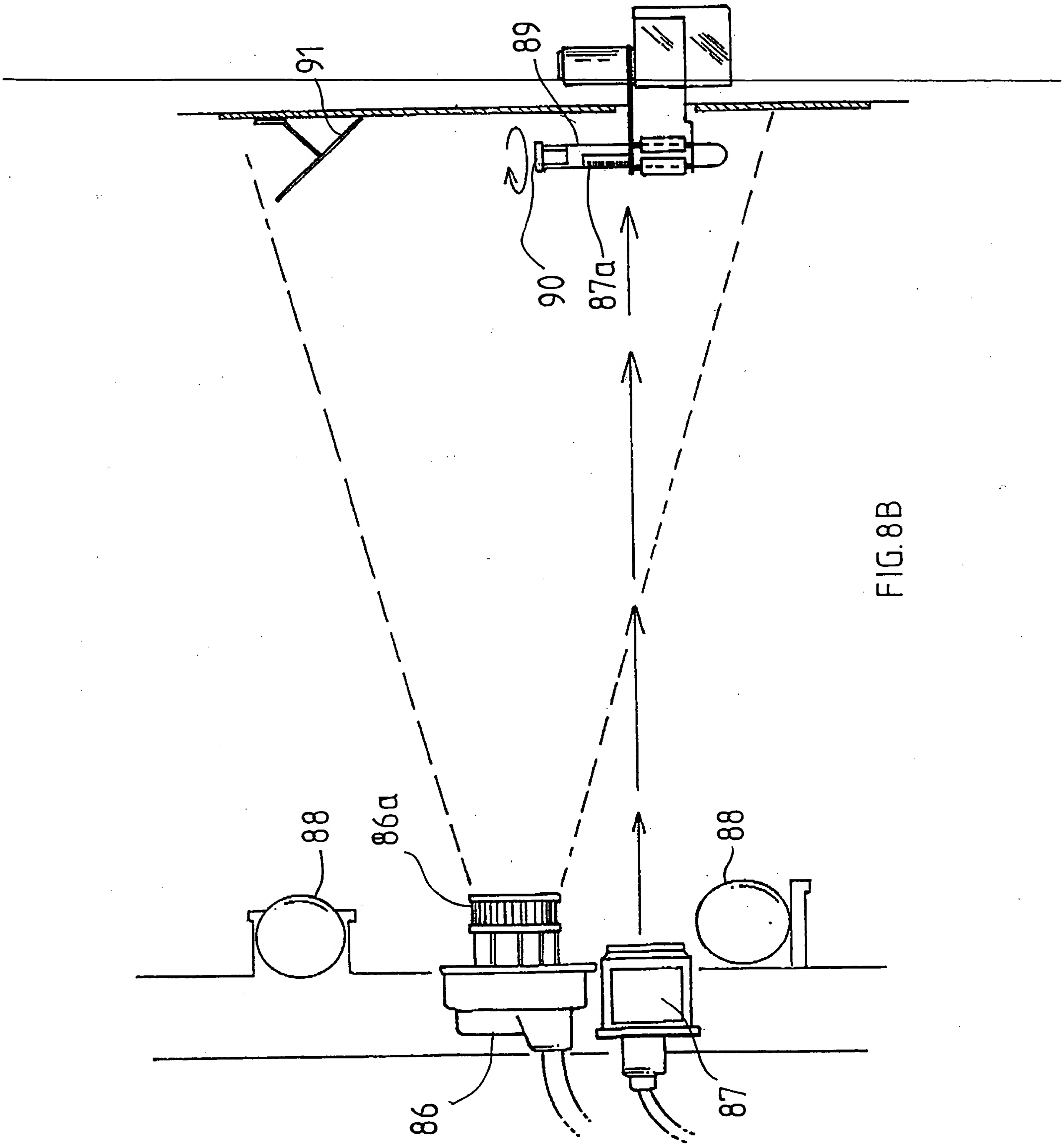

FIG.8B

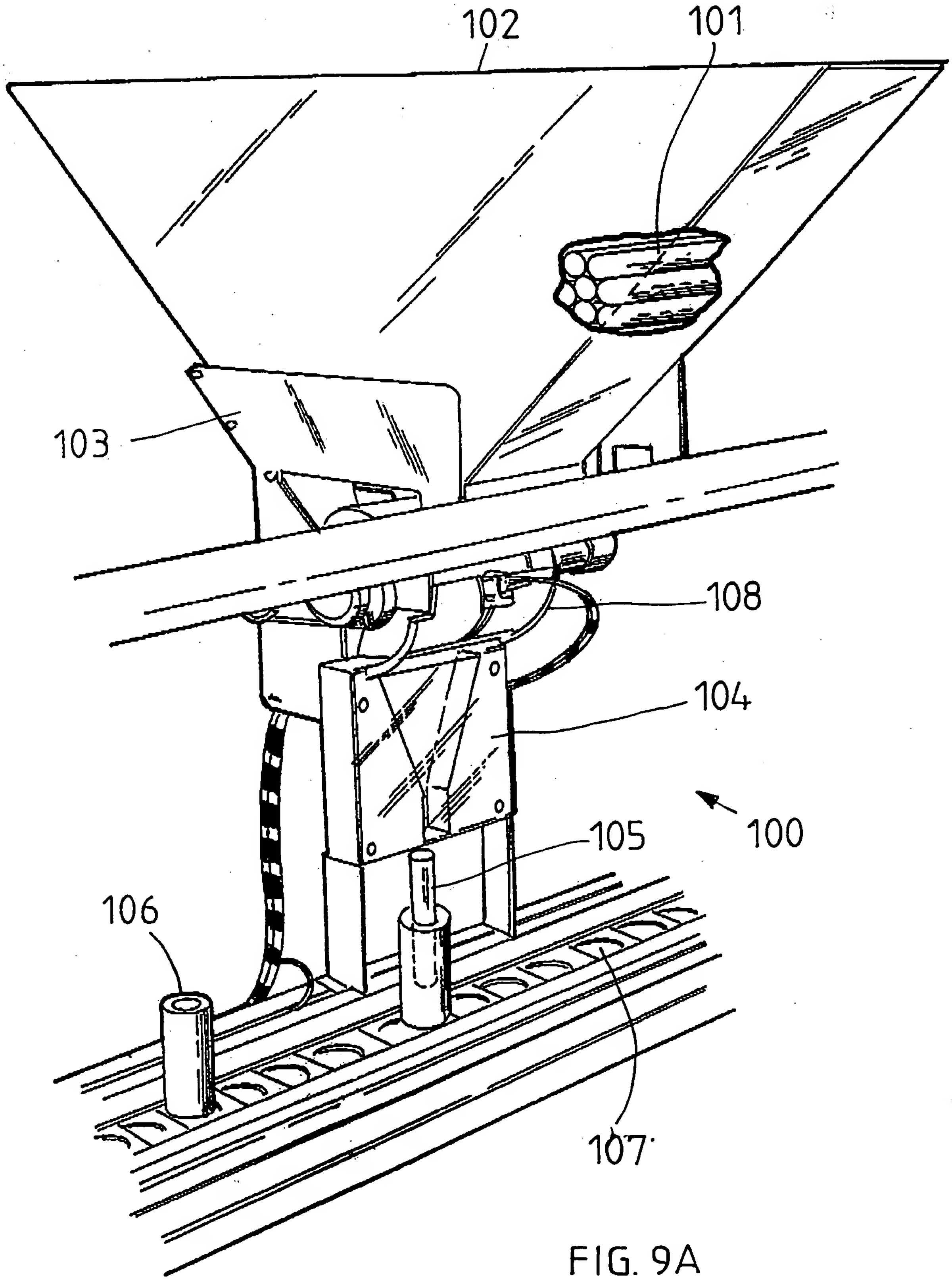

FIG. 9A

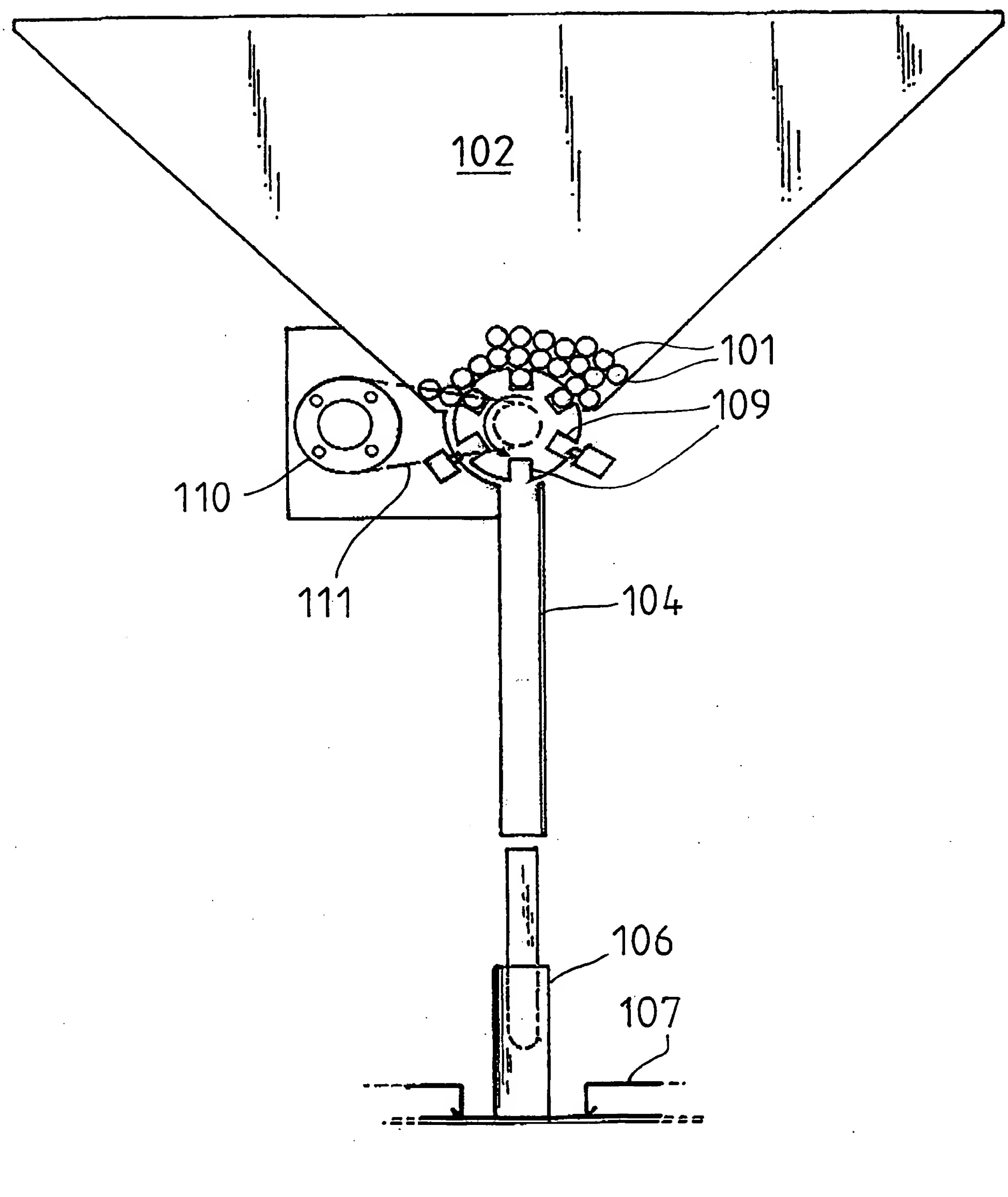

FIG. 9B

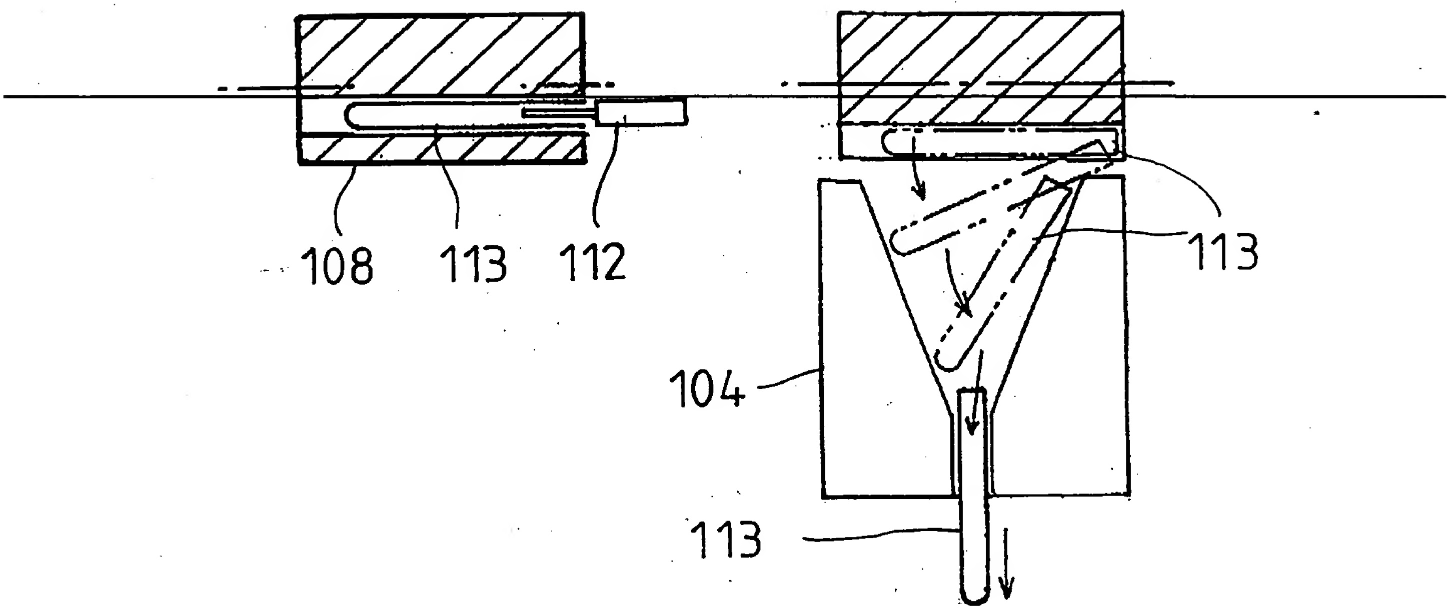

FIG. 9C

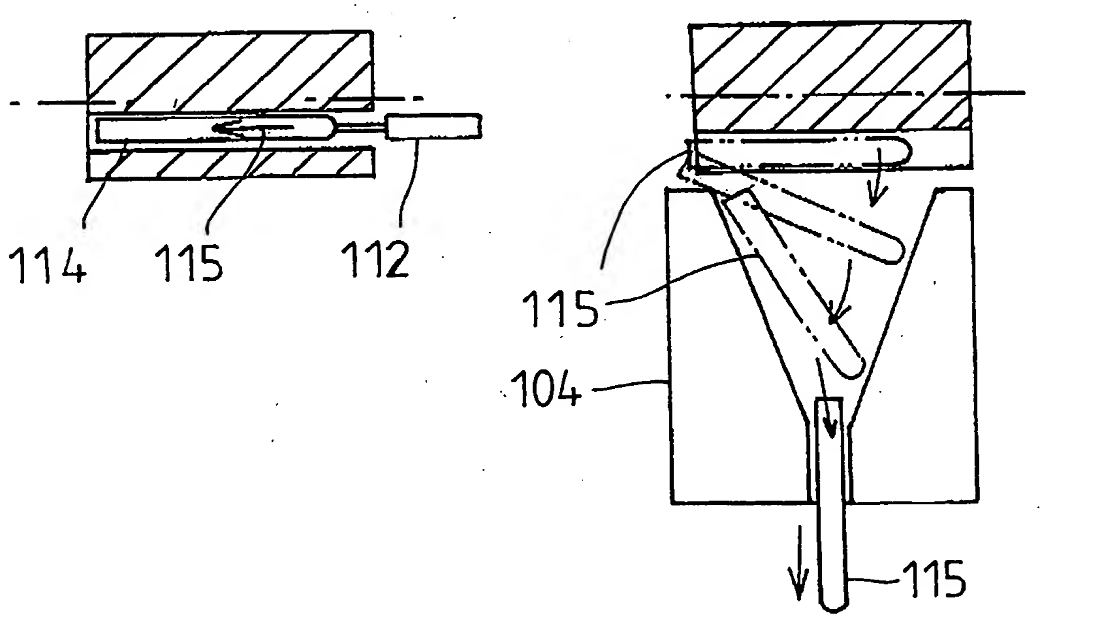

FIG. 9D

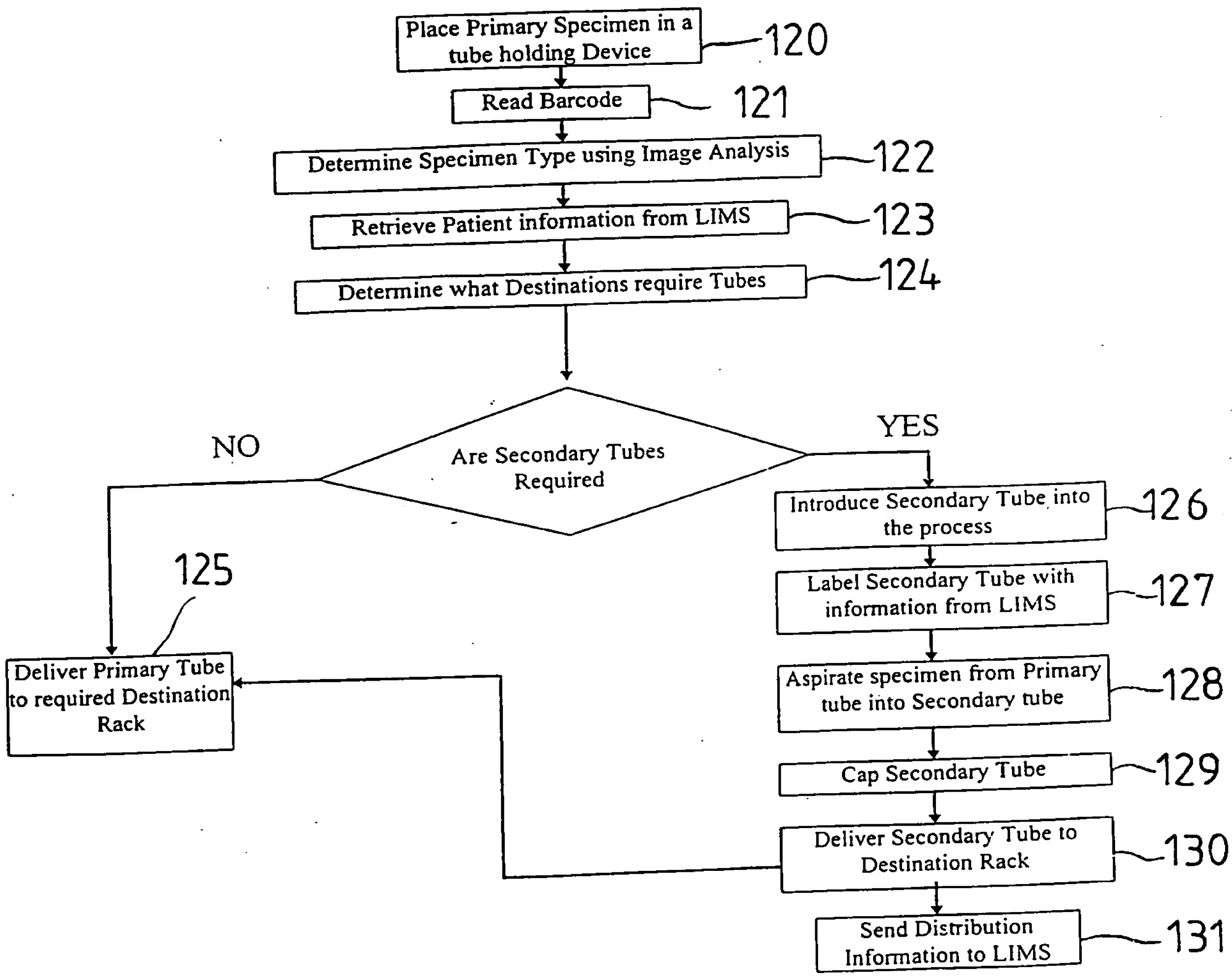
Place Primary Specimen in a tube holding Device
120
Read Barcode
121
Determine Specimen Type using Image Analysis
122
Retrieve Patient information from LIMS
123
Determine what Destinations require Tubes
124
Are Secondary Tubes Required
NO
YES
Introduce Secondary Tube into the process
126
Label Secondary Tube with information from LIMS
127
Aspirate specimen from Primary tube into Secondary tube
128
Cap Secondary Tube
129
Deliver Secondary Tube to Destination Rack
130
Send Distribution Information to LIMS
131
125
Deliver Primary Tube to required Destination Rack

FIG. 10